16:23:35 OCA PAD INITIATION - PROJECT HEADER INFORMATION 08/17/90

Active

Project #: B-03-601 Cost share #: Rev #: 0
Center # : 10/24-6-R6368-3A0 Center shr #: OCA file #:
Work type : RES
Contract#: 5 R29 LM04692-04 Mod #: Document : GRANT
Prime #: Contract entity: GTRC

Subprojects ? : N
Main project #:

Project unit: BEC Unit code: 03.010.203
Project director(s):
EZQUERRA N F BEC (404)894-7026

Sponsor/division names: DHHS/PHS/NIH / NATL INSTITUTES OF HEALTH
Sponsor/division codes: 108 / 001

Award period: 900801 to 910731 (performance) 911031 (reports)

Sponsor amount	New this change	Total to date
Contract value	104,832.00	104,832.00
Funded	104,832.00	104,832.00
Cost sharing amount		0.00

Does subcontracting plan apply ?: N

Title: KNOWLEDGE-BASED SYSTEM FOR CARDIAC IMAGE INTERPRETATION

PROJECT ADMINISTRATION DATA

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BETHESDA, MD 20892

Security class (U,C,S,TS) : U ONR resident rep. is ACO (Y/N): N
Defense priority rating : N/A NIH supplemental sheet
Equipment title vests with: Sponsor GIT X

Administrative comments -
INITIATION OF PROJECT. CONTINUATION OF B-03-F14. PUBLICATIONS SHOULD ACKNOWLEDGE NLM SUPPORT AND THE NLM SHOULD BE SENT 3 COPIES.

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

NOTICE OF PROJECT CLOSEOUT

Closeout Notice Date 09/11/91

Project No. B-03-601_____ Center No. 10/24-6-R6368-3A0_

Project Director EZQUERRA N F_____ School/Lab BEC_____

Sponsor DHHS/PHS/NIH/NATL INSTITUTES OF HEALTH_____

Contract/Grant No. 5 R29 LM04692-04_____ Contract Entity GTRC

Prime Contract No. _____

Title KNOWLEDGE-BASED SYSTEM FOR CARDIAC IMAGE INTERPRETATION_____

Effective Completion Date 910731 (Performance) 911031 (Reports)

Closeout Actions Required:	Y/N	Date Submitted
Final Invoice or Copy of Final Invoice	N	_____
Final Report of Inventions and/or Subcontracts	N	_____
Government Property Inventory & Related Certificate	N	_____
Classified Material Certificate	N	_____
Release and Assignment	N	_____
Other _____	N	_____

Comments_____

_____

Subproject Under Main Project No. _____

Continues Project No. B-03-F14_____

Distribution Required:

Project Director	Y
Administrative Network Representative	Y
GTRI Accounting/Grants and Contracts	Y
Procurement/Supply Services	Y
Research Property Managment	Y
Research Security Services	N
Reports Coordinator (OCA)	N
GTRC	Y
Project File	Y
Other _____	N
_____	N

equally large number of studies) and again present these cases to the KB system. The results will provide a comparison between interpretations made by the system and those made by experienced clinicians; similar studies will be conducted with non-experienced clinicians and scientists involved in the project. While the retrospective testing process is implemented, an assessment will be made of accuracy, failure analysis, robustness of the knowledge base, and reliability, emphasizing overall clinical utility and methods to enhance the usability of the system within the clinical setting.

In terms of identifying the priorities of the system such that optimal computational efficiency can be achieved, an analysis will be conducted of the "agenda" of the system: i.e., how input information flows into the system, how the groups of rules (knowledge islands) are invoked, and what changes can be made organizationally to the present architecture to maximize this flow of information. Several changes have already been made in this context. With respect to perfusion reversibility, this is one task that is significantly ahead of schedule and, in fact, was reported on in the reports of the previous two years; the task is completed and is now viewed as undergoing testing and evaluation. The refinement of vascular territories is also ahead of schedule, and the results of interpreting the cardiac images is now presented in terms of five vascular territories, as shown in the sample patient report of Appendix A. The arterial mapping scheme is ahead of schedule (reported in last year's report); this effort in terms of display has evolved beyond the scope of the proposed grant and in fact has become part of a new research direction aimed at unifying several different modalities in three dimensions (see the other grant cited under "Other Support" for the PI).

The system usage elements is likewise ahead of schedule but still under development. The patient report shown in Appendix A. The report is provided to the user as a "hard-copy" printout of the KB system's recommendations and conclusions. Efforts will continue to refine this report into a more useful form. Another system usage element still under refinement is the system's explanation and justification procedures. A method has been developed and implemented to conduct a tracing of a particular system consultation while giving the user the option of selecting different levels and types of tracings; this justification system will continue to undergo debugging and testing.

The unsupervised learning task has been modified into a supervised learning task via connectionist models. The learning will take place by presenting a backpropagation feed forward network with examples of different cases of myocardial thickening distributions in order to teach the system to recognize these patterns and infer myocardial viability.

The tasks which have fallen slightly behind schedule due to the unforeseen technical complexity are the low-level image processing operations to automatically select the orientation of the myocardium, and the testing of the additional patient-specific information such as symptoms and EKG results. The methods that will be explored for determining left-ventricular orientation will consist of model-based matching of the myocardial mass to stored templates of this mass at specific orientation angles, and conducted a search of landmark matching points in order to fit the model with the actual image data and subsequently extracting orientation information. The testing of the EKG results will be conducted as previously explained.

2. Studies Conducted During the Current Budget Year

There were several findings obtained during the previous year, including some positive results that accelerated the pace of research, while other results (already mentioned in the previous section) called for some changes and additional effort.

In keeping with the overall goal of developing a clinically useful system, the KB system was integrated into the clinical environment such that the knowledge-based interpretation was conducted as operator-free as possible. At present, the entire procedure is nearly completely automatic: from patient data acquisition to diagnostic interpretations, including providing a patient report shown in Appendix A. The territories assessed by the system were refined, from three (left anterior descending (LAD), right coronary artery (RCA), and left circumflex (LCX)) to five (these three and "LAD-or-LCX", and "RCA-or-LCX") in order to agree with the humans' process of diagnostic interpretation. In addition, the myocardial sectors involved are also specified, as shown in the lower left portion of the patient report of Appendix A.

The additional patient information originally proposed was also incorporated into the KB system. This includes symptoms (e.g., angina) and ST-segment depression. The inclusion of ST-segment depression was an important and difficult task, as it involved reconciling pre-test likelihood figures representing a probabilistic measure of coronary artery disease, with the heuristics of the certainty factor model for subjectively representing the estimated measure of disease (methods for accomplishing this were explained in last year's results).

A major contribution made during the current year was the development of a method to "trace" (i.e., track or follow) the reasoning strategy made by the system as it converged on its conclusions. This was done using the object-oriented software environment in the C programming language, and it now allows the user to choose several levels through which to track a particular conclusion.

The knowledge base's robustness was verified during the current year with a set of approximately twenty patients. It should be noted that verification is not as rigorous or complete as testing (for accuracy), or validation (which requires extensive testing and assessment retrospectively and prospectively). This verification was aimed at demonstrating the "correctness" of the changes and modifications introduced in the knowledge base during the current year, and the overall intent is to ensure stable and expected behavior when significant changes are made. The changes that have been made are significant in that the newly introduced rules handle reversibility of myocardial perfusion defects (showing ischemia versus infarction), as well as rules to handle the EKG results, and meta-level (i.e., high level) rules to conduct the tracing. The verification was completed and the actual retrospective testing and validation effort was initiated during the current year.

In terms of graphical display, the system is capable of providing a simple, grey-level display of the patient case being studied by the system (as shown in Appendix A). This enhances user interaction while also providing a "hard copy" of the information being processed. In addition to this display, the three-dimensional (3D) model of the arterial tree integrated with the myocardial perfusion distribution for visualization purposes (see the article in Appendix A).

These findings are part of publications under preparation or already submitted (see Publications section).

3. Human Subjects

NO special procedures or subjects are associated with this research; only previously existing data are used for this research. These data are generated as a result of the normal clinical procedures carried out at Emory University Hospital.

4. Invertebrate Animals

No invertebrate animals are used in this research.

5. Publications.

1. A Knowledge-Based System to Assist in the Diagnosis of Coronary Artery Disease; R. Mullick, N. Ezquerra, E. Garcia, and D. Cooke, submitted to the 13th. International Conference of the IEEE Engineering in Medicine and Biology Society.

2. Knowledge-Based Visualization of Myocardial Perfusion Tomographic Images, E. Garcia, M. Herbst, C. Cooke, N. Ezquerra, B. Evans, R. Folks, and E. DePuey, Proc. IEEE Conference on Visualization in Biomedical Computing, Atlanta, Georgia.

3. Technical Aspects of Myocardial SPECT Imaging with Technetium-99m Sestamibi; E. Garcia et al., American Journal of Cardiology, October 1990: 66-23E-31E.